Evolution of international carbon markets: lessons for the Paris Agreement

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Abstract: The Paris Agreement will greatly benefit from the past experience with international market mechanisms for greenhouse gas (GHG) emissions reductions and related regulatory systems, which have gone through four periods with specific challenges. The first period 1997 - 2004 operationalized the mechanisms defined in the Kyoto Protocol, the Clean Development Mechanism (CDM) and Joint Implementation (JI). Pilot activities in different sectors were undertaken by the public sector, and the first baseline and monitoring methodologies officially approved. Between 2005 and 2011, the carbon markets expanded massively. The EU emission trading scheme (EU ETS) was linked to the Kyoto mechanisms, creating demand for carbon credits from the private sector. During this "gold rush" period criticism emerged with regarding the uneven geographical distribution of projects, as well as environmental integrity problems related to baselines and additionality. The next period saw a collapse in carbon prices between 2012 and 2014, limiting the development of new projects. The quantitative limits on the offset use in the EU ETS were reached and the failure to agree on a new international regime resulted in a drying up of demand from governments. The 2015 – 2018 period is characterized by a gradual stabilization of the international climate regime. The Paris Agreement adopted in 2015 increases complexity through global participation in mitigation. Future carbon markets will therefore face both old challenges – supply-demand balance, environmental integrity, transaction costs – and new ones – interactions with other policies and national targets, and sectoral/policy baselines and additionality checks preventing hot air proliferation.

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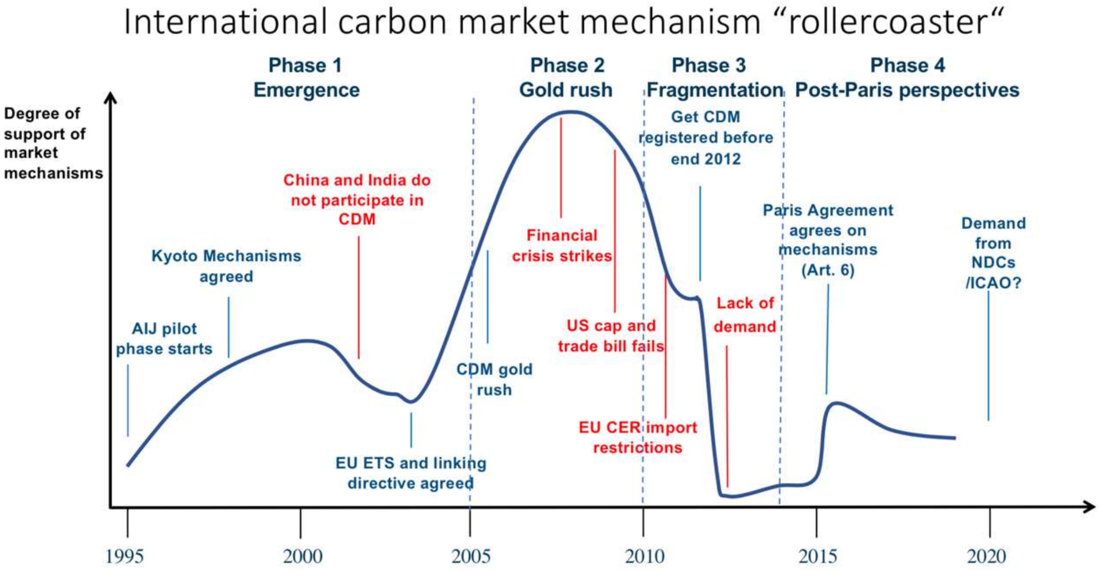
Abstract

The Paris Agreement will greatly benefit from the past experience with international market mechanisms for greenhouse gas (GHG) emissions reductions and related regulatory systems, which have gone through four periods with specific challenges. The first period 1997 - 2004 operationalized the mechanisms defined in the Kyoto Protocol, the Clean Development Mechanism (CDM) and Joint Implementation (JI). Pilot activities in different sectors were undertaken by the public sector, and the first baseline and monitoring methodologies officially approved. Between 2005 and 2011, the carbon markets expanded massively. The EU emission trading scheme (EU ETS) was linked to the Kyoto mechanisms, creating demand for carbon credits from the private sector. During this “gold rush” period criticism emerged with regarding the uneven geographical distribution of projects, as well as environmental integrity problems related to baselines and additionality. The next period saw a collapse in carbon prices between 2012 and 2014, limiting the development of new projects. The quantitative limits on the offset use in the EU ETS were reached and the failure to agree on a new international regime resulted in a drying up of demand from governments. The 2015 – 2018 period is characterized by a gradual stabilization of the international climate regime. The Paris Agreement adopted in 2015 increases complexity through global participation in mitigation. Future carbon markets will therefore face both old challenges – supply-demand balance, environmental integrity, transaction costs – and new ones – interactions with other policies and national targets, and sectoral/policy baselines and additionality checks preventing hot air proliferation.

Graphical/Visual Abstract and Caption



The roller coaster ride of international carbon market mechanisms over the last 20 years has four phases, ranging from exuberance (2005 – 2011) to hibernation (2012-2014), determined by changes in public and private demand for carbon credits and the varying ability of regulators to credibly operationalize the mechanisms.

Introduction

The rules for market mechanisms for climate change mitigation under the Paris Agreement are currently being negotiated and are expected to be adopted at COP25 in December 2019. These new mechanisms will greatly benefit from the past experience with international carbon markets under the Kyoto Protocol. In order to draw lessons from the past experience, we review changes in international market mechanisms for climate change mitigation and related regulatory systems from 1997 to 2016. Peer-reviewed literature is the backbone of our review while non-peer-reviewed sources have been used if they are published by an institution that has credible internal quality control processes. The following search terms were applied to the HEC Paris Library database of peer reviewed journal articles published between 1997 and 2018: ("carbon price" OR CDM OR "market mechanism" OR "carbon finance" OR "carbon credit" OR "Carbon Fund" OR "Clean Development Mechanism" OR "Joint Implementation" OR "regulatory regime" OR "Article 6" OR "Kyoto Mechanism" OR "baseline methodology" OR "additionality" OR "compliance market" OR "voluntary market" OR "Paris Agreement") AND ("carbon"). The initial search yielded 5353 results. After removing duplicates, we screened the titles of publications and removed those that were deemed irrelevant to the topic of the review. Out of the remaining 1148 papers we then excluded theoretical papers on emissions trading further narrowing the number of peer-reviewed papers to 792. 19 seminal papers and review articles were identified by recognized experts in the field after the general literature search. This was particularly important for literature on market mechanisms under the Paris Agreement due to the relatively recent emergence of the topic and lack of relevant academic literature that has passed the lengthy peer review process. The total number of articles reviewed thus increased to 811.

As a next step, we scanned through the abstracts of the retained papers and extracted key messages. Using expert review of the abstracts, a total of about 300 peer reviewed articles were retained in addition to about 40 papers from "grey literature". The remainder of the article presents the findings using a synthetic narrative along the four stages in the evolution of carbon markets: emergence, "gold rush", fragmentation and post-Paris perspectives. Specifically, for each of the four stages we draw lessons regarding the main features of the period and key market and regulatory challenges. Finally, we provide recommendations for future international carbon market mechanisms.

THE EMERGENCE OF CARBON MARKETS: 1997-2004

Main features of the period: conception and emergence of carbon markets

At the origins: the UNFCCC and the Kyoto Protocol

The practical concept of carbon markets emerged in the 1990s. The starting point was Article 4.2 of the UN Framework Convention on Climate Change (UNFCCC) with its rule on "Joint Implementation" (JI) for greenhouse gas (GHG) mitigation by several countries. This was seen as a window to develop market mechanisms by several European and North American countries. An early assessment of the US Initiative on JI, for instance, elaborated on the experience with 31 pilot projects in South-East Asia (e.g. carbon sequestration in Indonesia through reduced impact logging, and rural electrification in Sri Lanka) and derived recommendations for market mechanisms (Dixon, 1998). Given opposing views between developing and industrialized countries on whether such mechanisms made sense COP 1 in 1995 decided to start a pilot phase of the "Activities Implemented Jointly" (AIJ) lasting until 2000 without generation of emission credits. This allowed countries to test different market mechanism design options (see Dutschke and Michaelowa, 2003, for Costa Rica, which was a pioneering host country, and Springer, 2003, for the Swedish approach to invest in the Baltic states). Costa Rica was the first developing country to implement AIJ in several sectors including conservation, reforestation and renewable energy (wind and hydro). An assessment of 11 AIJ projects from the Swedish pilot program (energy efficiency and renewable energy in the Baltic countries) showed that project implementation costs were higher than projected, while GHG emission reductions were lower than ex-ante estimations. It was also suggested that such project risks can be mitigated by carbon funds through aggregation of demand (Springer, 2003).

While the economic rationale for industrialized countries to invest in activities in developing countries due to lower mitigation costs was not challenged, Zhang (1997) and Swisher (1997) identified various benefits and risks for developing countries. Presaging debates that fully erupted in the 2010s, some authors (Michaelowa and Schmidt, 1997) supported carbon crediting[1] for JI to

[1] A *carbon credit* is a generic tradable certificate or permit for GHG emissions reduced or removed from the atmosphere (e.g. tons of CO_2e) from generating mitigation activity. It is hence an instrument that represents ownership of a standardized unit of GHG emission reductions that can be traded, sold, retired or transferred. Crediting here refers to the issuance of a carbon credit (a tCO_2) for an equivalent reduction of GHG emissions. Offsetting refers to the use of carbon credits within different schemes, e.g., Certified Emission Reductions (CERs) could be used as offsets under ETS or domestic carbon pricing but can also be cancelled and hence contribute to net mitigation.

ensure efficient mitigation in the short term and mobilize technology transfer but proposed to progressively reduce the crediting in the long term to ensure innovation and research and development on low-carbon technologies/measures through increasing domestic carbon prices.

The Kyoto Protocol (KP), adopted in 1997, set GHG emissions reduction targets for 38 industrialized countries and economies in transition (EIT) – Annex B Parties to the Protocol. These mitigation targets were defined through emissions allowances – assigned amount units (AAUs) – allocated to countries. In order to maximize the economic efficiency of achieving their emission reduction or limitation targets, Annex B Parties were allowed to use three market mechanisms. They could exchange AAUs through international emissions trading (IET) and use carbon credits resulting from emissions reduction projects – Joint Implementation (JI) in Annex B countries (generating Emissions Reduction Units, ERUs) and the Clean Development Mechanism (CDM) in non-Annex B countries (generating Certified Emissions Reductions, CERs) (Shishlov et al., 2016)[2]. The CDM arose from the Brazilian Proposal's Clean Development Fund, and the concept was developed jointly by Brazil and the United States in the weeks preceding the Kyoto Conference of Parties in 1997 (Cole, 2012). The CDM project cycle typically involves the development of the Project Design Document (PDD), approval of the project by the host country through a Letter of Approval (LoA), validation by an independent auditor, project registration, monitoring of emissions reductions, independent verification, CER issuance and forwarding. All project documentation as well as monitoring reports are publicly available on the UNFCCC website giving the mechanism an unprecedented level of transparency, which in terms allowed for scrutiny by researchers and helped improve the mechanism (Shishlov and Bellassen, 2012).

Expected benefits from international carbon markets

In the late 1990s and early 2000s, many researchers foresaw significant benefits of the Kyoto Mechanisms. Jepma and van Der Gaast (2003) and Chen (2003) stressed their potential to achieve considerable mitigation cost savings and foster a multi-billion-dollar market for carbon credits. The size of the carbon market would be driven by Annex B demand, on the one hand, and institutional barriers in host countries, on the other (Michaelowa and Jotzo, 2005). Dutschke and Michaelowa (2003) emphasized the need for sufficient economic incentives for investors from developed countries investing in CDM projects in developing countries. For example, an early assessment of the power sector in Sri Lanka, Thailand, and Vietnam by Shrestha (2004) concluded that CER prices of USD 4-5/tCO_2e would support fuel switch from coal to gas and oil, but were insufficient to mobilize renewable energy (RE) projects. In order to maximize benefits, non-Annex I countries should participate actively in the rule design process for the flexible mechanisms (Painuly, 2001). Fehse (2003) highlighted capacity building and technology transfer benefits of the mechanisms, as well as co-benefits for biodiversity protection. In terms of the geographical potential, China emerged as potential frontrunner due to the high carbon intensity of the power sector and large potential for improving energy efficiency (EE) (Vrolijk and Liu, 2005).

2 The connotation of the term JI thus changed from the earlier terminology used in the UNFCCC. While initially the term JI indicated all activities tested during the initial introduction and test period of the market mechanisms, it later indicated only the activities that can be implemented in Annex B countries.

Key market and regulatory challenges

Concerns were raised regarding low demand and low credit prices (Jotzo and Michaelowa, 2002). The need to generate sustainable development (SD) benefits, and to support capacity building and data collection was identified by Begg et al. (2001) while Fichtner et al. (2002) and Kim (2004) noted that projects would need to strike a balance between aspiration to deliver SD benefits and their economic rationale. Chomitz (2002) and Geres and Michaelowa (2002) stressed the risk of carbon leakage and the need for monitoring, reporting and verification (MRV). The risk that "hot air"[3], i.e. surpluses of the domestic emissions budget could be "laundered" through JI was raised early on (Bollen et al., 1999; Jotzo and Michaelowa, 2002). Artificial arguments that baseline investments would be highly carbon-intensive in order to maximize credits were seen as risk by Schreuder and Sherry (2001). A solution for that problem would be clear rules for baseline determination to ensure environmental integrity (Dutschke and Michaelowa, 2003). Springer (2003) suggested to reduce technical, political and economic project risks through diversification and saw carbon funds as effective means in reducing private company risks.

Developing the project documentation, especially regarding additionality determination and baseline setting as well as third-party validation and verification were seen to generate transaction costs that could limit the scope of the CDM (Jotzo and Michaelowa, 2002). Small-scale projects were found to have disproportionally higher transaction costs, and special rules for such projects were therefore suggested as a potential solution (Spalding-Fecher et al., 2002; Michaelowa et al., 2003). Simplified rules and procedures were subsequently introduced from 2005 onwards (UNFCCC, 2006).

Additionality and baselines

Two of the key regulatory elements of the Kyoto Mechanisms discussed in the literature are baseline and additionality determination (Gustavsson et al., 2000; de Coninck and van der Linden, 2003). In the context of project-based mechanisms, the baseline is the reference scenario that is identified as the most likely in absence of the proposed project, and against which emission reduction can be claimed. Additionality indicates that the project would not have occurred anyway in absence of the revenue from sale of the carbon credits. This concept became one of the most contested issues for CDM activities starting from this initial period.

Case studies from the power sector in non-Annex 1 countries in 2001 highlighted the high risk for crediting activities that would be implemented anyway, also in the absence of the CDM, i.e. non-additional projects, which called for the definition of strong rules on additionality to ensure environmental integrity (Bernow et al., 2001). An assessment of 37 early CDM and 12 JI projects raised concerns on consistency and additionality (de Coninck and van der Linden, 2003).

Another issue that emerged relates to the perverse incentives leading to overestimation of baselines to maximize emission reductions potential, leading to difficulties in identifying credible baselines (Anagnostopoulos et al., 2003). Illum and Meyer (2004) stressed that project-based activities could only be seen as additional if the baseline was referring to the national energy system where the

[3] "Hot air" indicates the large surplus of AAUs in some of the emerging economies following the reduction of GHG emissions due to the collapse of the socialist economies.

project is implemented, capturing the real impacts of other projects implemented in the same energy system. Thus, a broader sectoral baseline was proposed. Inappropriate baseline settings ultimately lead to either missing "good" emission reductions opportunities that meet additionality requirements or to compromising the environmental integrity (Zhang et al., 2005).

THE "GOLD RUSH" PERIOD OF 2005-2011

The period 2005-2011 saw a strong growth of the international carbon markets, triggered by the 2004 decision of the EU on the "linking directive" allowing the use of credits from CDM and JI for compliance under the EU Emissions Trading Scheme (ETS). Under these circumstances, the mechanisms gained sudden popularity in the private sector and carbon markets grew much more than originally expected. However, the "gold rush" also exposed problems that were discussed intensely in the research literature.

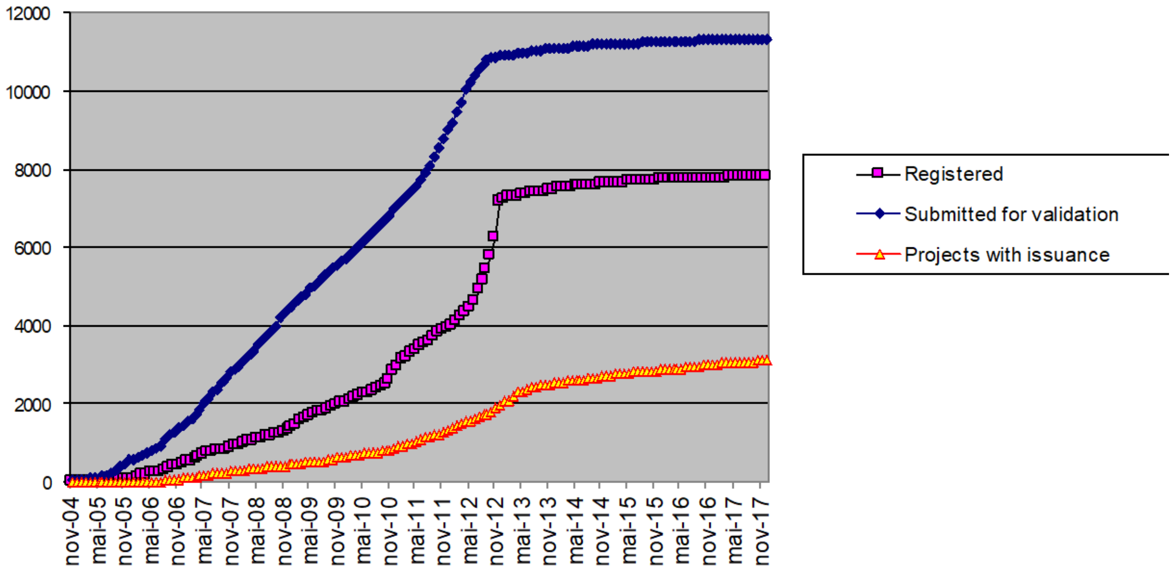
Main features of the period: growth and expansion of carbon markets

Supply and demand for carbon credits

The CDM was initially seen as a mechanism for countries that could support governments significantly reduce the cost of compliance with the KP (Bréchet and Lussis, 2006). But in practice both supply and demand for CERs was largely privatized and the CDM capacity to attract large private capital on an annual basis was an unprecedented and non-anticipated feature of the mechanism (Shishlov and Bellassen, 2012). On the demand side, this privatization was largely achieved thanks to the EU ETS which provided a large and reliable source of demand for CERs (ibid.).

While the initial use of offsets in the EU 2008-2009 was rather limited (Trotignon, 2012), market actors realized the cost-saving potential through the use of credits thanks to the EUA/CER price spread (Vasa, 2012) and the demand from the EU ETS grew in leaps and bounds leading to a "gold rush" period of the CDM. Figure 1 shows the trend in the pipeline of CDM projects submitted for validation, registered and those that issued CERs.

Figure 1. Accumulated number of CDM projects



Source: UNEP DTU (2019a)

The reduction of GHG mitigation compliance costs for firms in the EU and Japan was estimated at least around USD 2.3 billion for the period 2008 - 2012 based on the difference between CER and EUA prices (Spalding-Fecher, 2012). Additionally, for the same period (2008-2012) it was estimated that for the public sector, the use of CERs by Annex I governments to meet their Kyoto commitments yielded an additional USD 1.3 billion in savings (ibid.).

In 2005 it became also clear that the so called "unilateral CDM"[4] approach could be used, where stakeholders from developing countries are investing in a mitigation project in anticipation of potential carbon credit buyers and sell emission credits as a commodity. Unilateral CDM had the potential to attract investment in a more efficient manner compared to "bilateral" activities in specific circumstances, for instance through a reduction of transaction costs and low need of technology transfer (Michaelowa, 2007; Bayer et al., 2013a). Potential for unilateral CDM varied from country to country, depending on the domestic context and with African countries still depending on international support to a much higher degree than other developing countries in Latin America and Asia (Michaelowa, 2007).

While the regulatory uncertainty about the CDM did not allow CER and EUA prices to fully converge (Mizrach, 2012), a clear correlation was observed (Sadefo Kamdem et al., 2016). It was demonstrated how price volatility was exacerbated by the decisions of the European Parliament and suggested the need for policymakers to improve communication of long-term strategies for the EU ETS (Deeney et al., 2016). Moreover, concerns about price volatility in the primary market due to imperfect information were also raised (Zavodov, 2012).

[4] Unilateral CDM are those project activities that are implemented by developing countries and the CERs generated by these activities are sold without any participation from Annex I countries.

Learning by doing through expansion of the market

Being the first-of-a-kind climate change mitigation instrument, the CDM followed a "learning by doing" pattern, whereby the transparency of the mechanism allowed for scrutiny by researchers and NGOs leading to numerous reforms (Shishlov and Bellassen, 2012). The CDM, as well as voluntary offset schemes, helped developing countries in building technical capacity regarding structuring of emissions reduction projects and carbon accounting (Mehling and Mielke, 2012). Indeed, a common view among stakeholder inputs to the CDM Policy Dialogue was that capacity-building for the low-carbon transition in developing countries was one of the most important impacts of the CDM (Spalding-Fecher, 2012). Especially in large emerging economies like India, China and Brazil very rapidly an "ecosystem" of CDM consultants emerged (Michaelowa and Michaelowa, 2011).

In this phase, private financial institutions were actively participating in the carbon markets as intermediaries, enhancing liquidity of the market (Weber and Darbellay, 2011), especially in large countries like China (Fan et al., 2011). While they did not contribute actively to rule setting for CDM regulatory mechanisms (Haigh, 2011) carbon funds can play a fundamental role in pooling demand for credits. Moreover, carbon funds are one of the main drivers that enable development banks to support CDM dissemination especially in low income countries in Africa (Karani and Gantsho, 2007).

International carbon markets and domestic climate policies

The CDM and international carbon finance were also assessed against domestic mitigation policies. Strand (2011) identified a perverse incentive of the CDM to weaken domestic energy and environmental policies to leave sufficient potential for emission credits sales through the CDM. Such considerations led to the definition of the so-called E+ and E- policies to be considered when identifying the baseline. According to the UNFCCC (2005), E+ policies are "national and/or sectoral policies or regulations that give comparative advantages to more emissions-intensive technologies or fuels over less emissions-intensive technologies or fuels", while the E- policies are "national and/or sectoral policies or regulations that give comparative advantages to less emissions-intensive technologies over more emissions-intensive technologies (e.g. public subsidies to promote the diffusion of renewable energy or to finance energy efficiency programs)". The E- rule stated that mitigation policy instruments introduced after the Marrakech Accords do not need to be considered in assessing additionality of CDM projects.

Key market and regulatory challenges

Economic efficiency, environmental integrity and contribution to sustainable development are among the key challenges faced by the international carbon market in this period (Shishlov and Bellassen, 2012; Lewis, 2009). As one extreme, Wara (2007) saw the CDM as an ineffective instrument with limited results in reducing global GHG emissions. One of the challenges raised with regards to the CDM was the problem of "low-hanging fruits" being captured by the market, potentially precluding countries from taking on more ambitious targets (Akita et al., 2012; Peter and Bumpus, 2012). Quantitative assessment, however, demonstrated that a project-based mechanism like the CDM could only capture a small share of cheap abatement opportunities, with a notable exception of China, where it captured almost a third of theoretical low-cost abatement potential (Castro, 2012). Difficulties in the equalization of marginal abatement costs across sectors were identified by Millard-Ball and Ortolano (2010). Cormier and Bellassen (2013) assessed CER issuance risks and found 29% of CERs lost due to failure of projects (negative validation, project withdrawn, etc.), 12% due to delays during the approval process (validation and registration), 27% due to delays at issuance, and only 1% due to underperformance of projects in terms of CER delivered per day. Only 30% of expected CERs had actually been issued by mid-2011.

This unbalance in favour of GHG emissions reduction over contribution to SD in the CDM postulated in the first period was now assessed empirically and supported by a text analysis of 744 PDDs submitted until May 2006 (Olsen and Fenhann, 2008), an assessment of 40 projects from India (Alexeew et al., 2010), and small samples of 16 (Sutter and Parreño, 2007) and ten projects (Boyd et al., 2009), respectively. Olsen (2007) provided a thorough literature review up to 2007. Particularly hydro projects were criticized (Finley-Brook and Thomas 2012). Haya and Parekh (2011) identified 6 CDM hydro projects that resulted in considerable adverse impacts. Lack of proper stakeholder consultation and potential conflicts of interest in the project approval process are considered as possible reasons for the cases of human rights violations (Shishlov and Bellassen, 2012).

At the same time, “add-on” standards, such as, for example, the Climate, Community and Biodiversity (CCB) or Gold Standard used by certain projects have delivered over-proportional co-benefits for poor populations (Crowe, 2013) and local SD in general (Nussbaumer, 2013). Parnphumeesup and Kerr (2015) found that 56.4% of the buyers were willing to pay a price premium (on average EUR 1.12/tCO_2e) for carbon credits certified under the Gold Standard. Lenzen et al. (2007) and Olsen and Fenhann (2008) proposed the development of sophisticated tools to prioritize activities from a SD contribution standpoint that could also be used as a verification protocol for MRV on the SD impacts. The CDM subsequently adopted a SD tool for voluntary use by project participants, although it aims at highlighting positive SD impacts rather than being an MRV tool.

China was seen as giving preference to CDM projects in poorer and less developed provinces and provinces that lack foreign direct investments (FDI) in order to maximize economic co-benefits (Bayer et al., 2013b; Hong et al., 2013). Energy-related CDM activities in China were seen to deliver substantial health benefits effects and monetary savings (Vennemo et al., 2006). However, an assessment of selected hydropower projects in Yunnan province argued while the CDM might have contributed to boosting hydropower development, their benefits were often not channelled to local communities (Rousseau, 2017).

Going beyond projects

The project focus of CDM was increasingly seen as outdated. One significant evolution of the CDM beyond single projects is the introduction of the concept of Program of Activities (PoA) in 2005. This option allows the registration of multiple activities of the same type without any limit of the number over a period of 28 years. PoAs reduce transaction costs (Matschoss, 2007), which was confirmed by empirical studies, such as in the case of a PoA for compact fluorescent lamps (CFL) dissemination in Chile (Karakosta and Askounis, 2010). Suykens (2010) and Duan (2011) proposed sectoral crediting mechanisms and explained their design using the case of utilization of associated gas.

Addressing the uneven geographical distribution

The familiarity factors (colonial history; bilateral trade; and bilateral aid) strongly influence CDM location decisions (Dolšak and Crandall, 2013). Evidence of CDM projects following closely traditional FDI patterns was found by von Unger and Streck (2009). Availability of human capital, mitigation potential, which is indicated by the carbon intensity, existence of profitable markets for CDM co-products (e.g. electricity) increases the chances of hosting CDM activities (Winkelman and Moore, 2011). A comparative analysis of the CDM experience in China and South Africa demonstrated that a strong industrial and energy policy in the host country plays a crucial role in the development of CDM (Fay et al., 2012). Policies fostering a low-carbon development pathway encourage the CDM uptake, rather than CDM driving a low-emission development pathway. In addition, the active engagement by key government and private sector stakeholders and the presence of a friendly business environment are crucial. Lack of capacity of local actors, aggravated by limited access to financing, was identified as a key barrier for entrepreneurship in in the CDM in South Africa (Dolles et al., 2013).

In the case of Africa and Least-Developed Countries (LDCs), donor agencies provided USD 45 million for CDM related capacity building until 2009, equivalent to 8% of the total carbon revenues from these countries. Training activities, for instance support in establishment of the Designated National Authorities (DNAs), were more successful than activities targeting project mobilization. Efficiency of assistance was higher when the full CDM process and cycle was supported rather than parts of it (Okubo and Michaelowa, 2010).

Van der Gaast and Begg (2009) find that PoAs can support a more balanced distribution of CDM activities. However, the successful use of PoAs is contingent on establishing an appropriate institutional framework, building local capacity, increasing institutional learning around project development, and harmonizing evolving carbon finance mechanism (Schomer and van Asselt, 2012, Hwang and Kim, 2011). Combining market mechanisms with micro-finance can help scale household programs, such as for example in the case of the diffusion of solar lanterns through micro-loans (Hogarth, 2012) and thus open new opportunities also for underrepresented countries and populations.

Additionality

The additionality of CDM projects continued to be severely criticized during the CDM “gold rush” (Streck and Thiago, 2007; Streck, 2011; Koo, 2017). When regulators replaced the barrier test by an investment test, this immediately resulted in the share of non-additional projects falling substantially (Michaelowa and Butzengeiger, 2017). An assessment of projects in India and Brazil finds that due to the uncertainty of CDM revenues, project developers preferred projects viable without CDM credits (Hultman et al., 2012). Doubts were raised on the additionality of small hydro projects in China (Wu and Chen, 2011) and for wind projects (He and Morse, 2013) (in general for China: Lewis, 2010). An assessment of bagasse power CDM projects in Brazil, India and Thailand (Amatayakul and Berndes, 2012) found that power purchase agreements rather than carbon credit sales were decisive for project implementation. Both articles ignore the E- rule due to which revenues from feed-in tariffs are not accounted for under the CDM. Fearnside (2013) argues large hydro projects in Amazonia would have likely been implemented without the CDM. For small hydro, Martins et al. (2013) found that, among the 431 projects which became active in Brazil since 2001, 339 were not CDM projects and thus the role of CDM revenue as an incentive was uncertain. Looking at renewable energy projects, Gilau et al. (2007) suggested that CDM should move away from a purely “market-oriented“ perspective towards barrier removal.

It is acknowledged that in practice, it is virtually impossible to ensure additionality in 100% of the cases (Shishlov and Bellassen, 2012). The natural contradiction between strict additionality and not impeding new environmental policies at the national level partly explains this. The higher transaction costs which come together with a stringent case-by-case scrutiny are another explanation. More stringent baselines and performance benchmarks can help ensure net emissions reductions that could compensate for non-additional projects that manage to slip through. Ultimately, the additionality test thus becomes a matter of finding the right balance between: “false positives and false negatives” (Carmichael et al., 2016). Relaxing the additionality demonstration on a project basis, but at the same time strengthening additionality on a technology level is one potential option to address the additionality issue (Chung 2007; Castro and Michaelowa, 2010). The CDM would have to move away from a pure offset mechanism through discounting the volume of CERs generated (i.e. allowing crediting for only a certain share of total CERs generated, thus rendering not tradable the remaining share) in order to deliver net mitigation benefits for the world as a whole and ensure additionality at an aggregated level (Schneider, 2009).

Baselines

Like additionality, baseline determination continued to be controversial during this phase. Strand and Rosendahl (2012) argued that the asymmetry of information between the regulator (the CDM Executive Board) and the companies participating in the CDM may result in higher emissions baselines due to the potential to manipulate data and hence increase overall emissions. A similar result was identified also for the voluntary carbon market looking at energy efficiency for buildings in the US (Liu and Cui, 2017). Conservative baselines depending on uncertainty of baseline setting and credit price levels have been proposed as a possible solution (Bento et al., 2016). Other options such as standardization of baselines has been suggested to address these issues (Murtishaw et al., 2006; Zhang et al., 2006). Standardized baselines were calculated for the South African Power Pool (Spalding-Fecher, 2011). This was taken up by the regulators in the post-2010 period.

Technology transfer

Unlike the contribution to sustainable development, technology transfer is not an explicit objective of the CDM, but it represents an important co-benefit for host countries and has been widely researched (Schmid, 2012; Cox, 2010; Youngman et al., 2007). In contrast to other co-benefits, the existing evidence which started emerging during this phase is particularly inconsistent. While in some views (Schneider et al., 2008) CDM is seen as effective in supporting technology transfer, lowering existing barriers and enhancing the quality of the transfer, other assessments (Youngman et al., 2007) concluded that around 50% of CDM projects and 62% of JI involved hardware from outside the host country by 2007. However, other researchers (Doranova et al., 2010) came to an opposite conclusion with a majority of CDM activities using domestically produced technologies. Heterogeneous technology transfer results have been identified across CDM project types with different degrees of reliance on imported technology (Karakosta et al., 2012). Others (Das, 2011) reported that technology transfer impacts depend largely on the project type/technology.

An empirical assessment of the barriers that may slow down technology transfer through carbon markets identified high tariffs on environmental goods and services as well as burdensome administrative procedures to launch new businesses as key factors. Other findings indicated that technology transfer is driven by minimization of the abatement cost rather than actual alignment with host country priorities and needs (van der Gaast et al., 2009).

A case study of wind power CDM projects in China and India (Lema and Lema, 2013) demonstrates that while technology transfer does occur, it is based on mechanisms available prior to and independent of CDM projects. This means that CDM projects tend to use technology transfer mechanisms and options already available in the country and independent of the CDM component not the other way around. In China the proportion of total income generated by CERs is high and the domestic availability of the technology is low, which drives the choice of project owners to use foreign technologies (Wang, 2010). On the other hand, only limited incentives are identified for technology transfer in the Chinese renewables sector (Wang and Chen, 2010).

Governance

During the gold rush period, governance issues became highly relevant, especially under the CDM with a strong participation of private companies. Governance is relevant both on the international and national levels. Regarding the former, CDM project developers highlight the issue of lack of transparency on the Executive Board (EB) decision on projects, lack of a mechanism to review or appeal EB decisions, and limited possibility for interaction along the process. This is a consequence of the unique nature of the CDM, where the UN directly interacts with the private sector. An econometric assessment of 250 CDM methodologies and around 1000 registered projects shows that EB's final decisions are determined by both formal quality criteria and also on political-economic variables (Flues et al., 2010). Likewise, business and industry NGOs influenced decision-making on CCS under the CDM (Vormedal, 2008). Developed countries and emissions-intensive companies are effectively influencing the negotiation and the actual implementation of the flexible mechanisms (Vlachou and Konstantinidis, 2010). In contrast, some authors see a very limited NGO influence on the CDM and other carbon markets (Lederer, 2012).

The governance structures of the CDM and voluntary markets for carbon offsets are often criticized as subject to capital-accumulation strategies without public oversight (Bumpus and Liverman, 2008; Lövbrand et al., 2009). The CDM criticism is reflecting the effectiveness and legitimacy of the environmental governance at international level (Jacur, 2009). Other authors expressed fears regarding the fact that in the context of oppressive societies market mechanisms can lead to harmful effects for the indigenous communities and it is thus necessary to introduce a mechanism for protecting their rights under the CDM (Finley-Brook and Thomas, 2011). The case of hydropower development in Yunnan Province in China shows that CDM did not contribute to delivering SD benefits but it rather consolidated existing power structures (Rousseau, 2017). However, there is room for improving interactions between the various stakeholders and regulators and increase participation (Millar and Wilder, 2009; von Unger and Streck, 2009). Governance reforms could allow the CDM to become a more effective and credible international instrument (Purdy, 2009). Several proposals were brought forward, such as professionalization of the EB and appropriate administrative rule with an appeal process to increase transparency (Lin and Streck, 2009; Streck and

Lin, 2008). While an appeal process was not introduced to date, several improvements such as granting the possibility of discussing directly through a phone call with the UNFCCC Secretariat the outcome of PDD evaluation to clarify issues, were introduced. An assessment of the commercial activities of the participants to UNEP Risoe's CDM Bazaar shows that different regulatory designs have strong implications on value chain creation, for example influencing the role of specialized CDM consultancies (Schneider et al., 2010).

A key regulatory issue during this phase was the issue of auditing project rule conformity and GHG emission reduction which is performed by third parties accredited by the CDM EB, the so called Designated Operational Entities (DOEs). These entities are hired by the project owners for performing the validation and, except in the case of small-scale projects, the DOE validating projects cannot verify the emission reductions generated by the projects. DOEs need to check the conformity of proposed activities against the set of requirements and rules defined by the EB. Researchers emphasized the inherent flaws of delegating authority under the CDM to private actors (Hickmann, 2013) while others pointed to the fact that the risk of losing accreditation outweighs the potential benefits of gaming the system (Shishlov and Bellassen, 2012). Third party auditors also faced challenges in safeguarding environmental integrity, due to lack of clear guidelines on how to interpret existing rules and requirements for CDM activities, hiring of DOEs by the project owners and resulting in pressures on projects registration, time and ability of the DOEs in developing sufficient internal expertise (Dyck, 2011). Researchers pointed out that interactions between buyers and verifiers, including disputes, should be regulated in a stable legal framework (Simonetti, 2010). Introduction of a materiality threshold for verification at UNFCCC level might reduce transaction costs and increase DOEs' objectivity in validations and verifications, reducing inconsistencies (Cole, 2011).

When assessing the differences among host country domestic CDM governance structures, links can be identified to the specific governance structure in each country (Newell, 2009). A combination of the CDM and carbon tax for developing countries (where emission reductions achieved under the carbon tax can be exported) was proposed by Timilsina (2009) to increase host country welfare; actually a number of countries are now combining carbon taxes with the CDM, e.g. Mexico and Colombia.

FRAGMENTATION OF CARBON MARKETS IN 2012-2014

Main features of the period: volatility and decline of carbon markets

Falling demand for carbon credits

The main source of demand for CDM and JI credits - the EU ETS - started to fade in 2011-2012 as the issuance of CERs and ERUs started reaching the quantitative limits on the use of offsets. This limit was set in order to ensure that at least half of the emissions reductions necessary under the KP would be achieved domestically. This is often referred to as "supplementarity principle" (Michaelowa, 2014). The initial no-cap option under the EU Linking Directive was pushed by EU Member states but the EU commission prevailed (Flåm, 2009). The total demand for international carbon credits from the EU ETS was thus estimated at around 1.6 billion tCO_2e until 2020 (Bellassen et al., 2012).

Another important source of demand for carbon credits came from governments of countries – most notably Japan – that required them for compliance under the KP. Indeed, the analysis of the final data for national GHG emissions and exchanges in carbon units during the first KP Commitment Period demonstrated that overall, the Annex B parties to the KP surpassed their aggregate commitment and that all individual countries were in compliance, with 9 of 36 countries – Austria, Denmark, Iceland, Japan, Lichtenstein, Luxembourg, Norway, Spain and Switzerland – achieving it only thanks to the use of flexibility mechanisms (Shishlov et al., 2016). This source of demand was estimated to be around 300 million tCO_2e between 2008 and 2015 (Bellassen et al., 2012).

Heindl and Voigt (2012) estimated that should the OECD countries fulfil the "Copenhagen Pledges" and seek cost containment, the potential demand for carbon offsets would be 627-667 $MtCO_2e$ per year. However, the "Copenhagen pledges" were never translated into binding emissions reduction targets, e.g. under the second Kyoto Commitment period. Moreover, the Doha Amendment that prolongs the Kyoto Protocol into its second Commitment Period (2013-2020) never entered into force, since it was not ratified by a sufficient number of countries.

Increasing supply of carbon credits

On the supply side, the CDM was stably delivering CERs. The supply of offsets is also weakly sensitive to prices: once the initial investments in a project are undertaken, it makes sense to issue CERs as long as carbon revenues exceed marginal operational and transaction costs (Shishlov and Bellassen, 2012). It was demonstrated that transaction costs for CDM projects range from less than USD 0.1/tCO_2e for large industrial gas projects to USD 1.5/tCO_2e and above for small-scale projects (Shishlov and Bellassen, 2016). Towards the end of the first Commitment Period there was a large increase of issuance of carbon credits from JI projects in Russia and Ukraine, which is usually explained by the rush to sell credits before the demand fades. This "flood" of JI credits further contributed to the oversupply of the market although this was forecasted ex-ante (Korppoo and Gassan-Zade, 2014).

Green Investment Scheme

The Green Investment Scheme (GIS) concept was introduced in order to tackle the issue of "hot air", i.e. large surpluses of AAUs accumulated in Eastern European countries. Under a GIS, the revenues obtained by a country from the sale of surplus AAUs must be invested in domestic emission reduction activities or policies. The GIS is therefore supposed to link the surplus AAUs trades to tangible emission reductions, although not necessarily preserving the ratio of one AAU per tCOeq abated (Shishlov et al. 2012). GIS have had various degrees of success, failing in Ukraine (Korppoo and Gassan-Zade 2014) while working well for certain energy efficiency technologies in the Czech Republic (Karásek and Pavlica 2016).

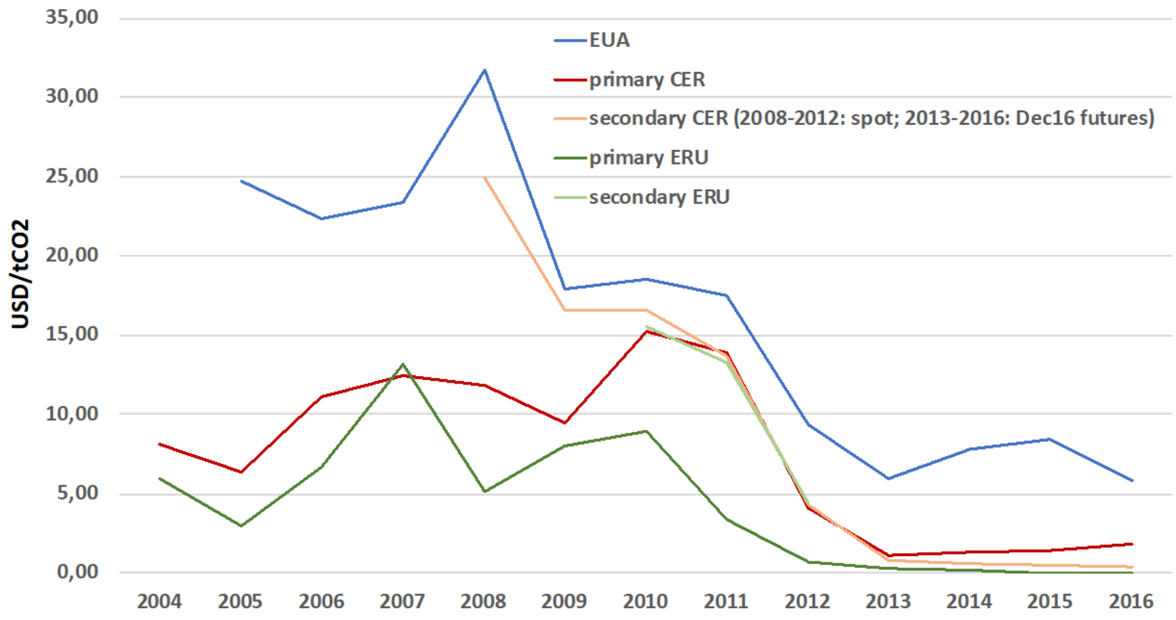
Steadily increasing supply of carbon credits was thus rapidly saturating the aggregate demand – from the EU ETS and national governments – which was estimated at between 1.6 and 1.9 billion

tCO_2e until 2015 (Figure 4). Based on this supply-demand disequilibrium Bellassen et al. (2012) forecasted that CER and ERU prices would collapse, which proved prophetic.

Falling carbon credit prices

CER prices were largely correlated with the EUA prices until late-2011 (see figure below). EUA prices have been following an overall downward trend following the economic recession, emissions reductions due to other policies (e.g. renewable energy), as well as the inflow of international offsets (Koch et al., 2014). As the CER import limit was filling up, starting in late-2011 an increasing decorrelation between EUA and CDM credit prices could be observed culminating in CER prices collapsing below EUR 1/tCO_2e.

Figure 2: Annual average CER, ERU and EU allowance prices 2004 - 2016



Data sources: Point Carbon (EUAs), Bluenext/EEX (secondary CERs/ERUs), World Bank reports on the state of the carbon markets

Voluntary carbon markets:

Voluntary carbon markets have emerged in various jurisdictions and triggered various privately managed standards of which Verra (formerly Verified Carbon Standard) is the biggest one. Prices of credits vary significantly event among projects of the same type and are intransparent. Some voluntary markets use credits from international carbon markets. The total volume of credits traded on voluntary market is only a few percent of the international and national compliance markets. Hamrick and Galant (2017) provide a thorough overview about the current status of the voluntary markets.

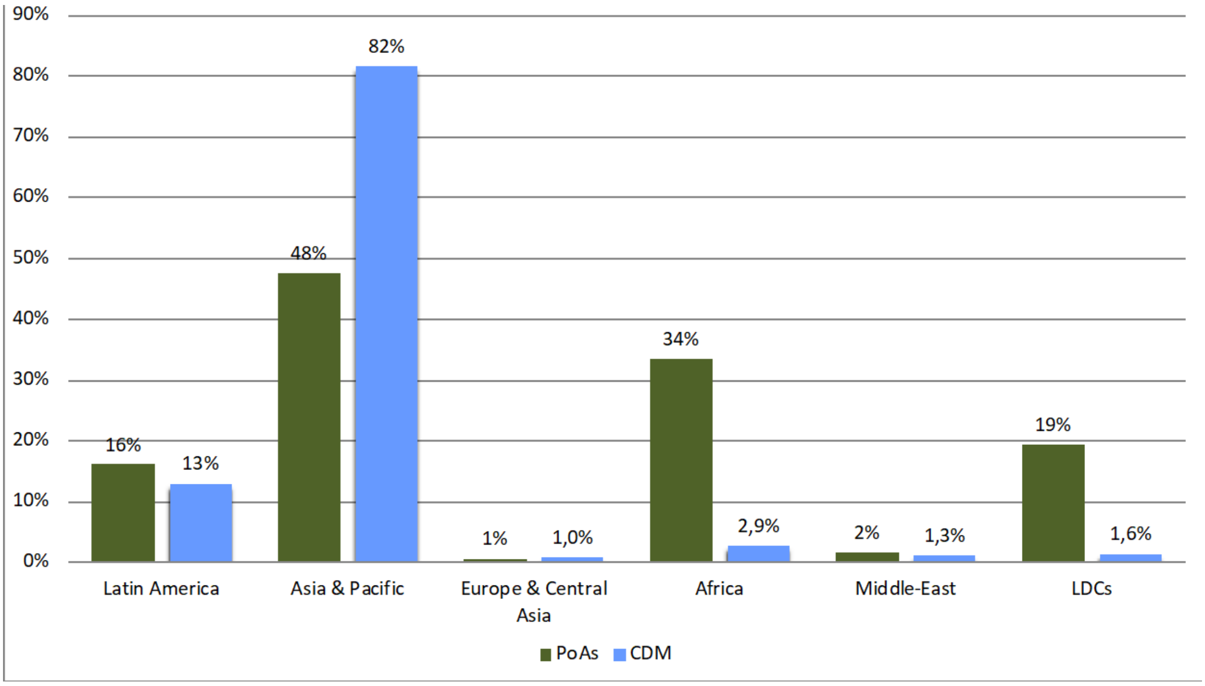
Key market and regulatory challenges in this period

Projects squeezed between falling demand and rising supply costs

While the CER prices were falling, the costs of mitigation actions under the CDM were going up with time as project developers started to exhaust the cheap options (Rahman et al., 2015). The fall in carbon prices combined with regulatory uncertainty on the future of the CDM in the post-2012 climate regime resulted in a drastic decrease in the number of new CDM project registrations.

The fall in carbon credit prices was particularly painful for LDCs where PoAs had finally started to foster many new projects and where past capacity building had started to bear fruit (Kreibich et al., 2017). Indeed, by 2017 Africa represented 34% of PoAs compared to only 3% of regular CDM projects, while LDCs accounted for 19% of PoAs compared to only 1.6% of regular CDM projects (**Figure 3**). The declining market, however, threatened the gradual loss of this accumulating capacity of low-income countries to develop low-carbon projects.

Figure 3. Geographical distribution of PoAs and CDM projects until 2017.



Source: UNEP DTU (2019b)

The accumulating experience with PoAs focused on household appliances in developing countries demonstrated that the uptake of new technologies might be much lower than expected. This was confirmed by case studies of projects focused on improved cookstoves in India (Aung et al., 2016) and Kenya (Freeman and Zerriffi, 2014) and water filters in Kenya (Pickering et al., 2017) raising issues about ex-post monitoring of emissions reductions and other co-benefits. It was suggested that more rigorous research was needed for underlying assumptions and monitoring approaches for household water treatment projects (Summers et al., 2015) and cookstoves (Lee et al., 2014).

However, these results are not unequivocal, as at the same time, a case study of improved cookstoves and water filters in Rwanda demonstrated very high uptake rates. It was suggested that continued engagement with households contributed to high adoption rates (Barstow et al., 2016).

An important challenge in using carbon finance for low-income households is that the current consumption may not reflect the real need for basic services. The CDM rules have evolved to include the consideration of this “suppressed demand” in baselines, but challenges remained to balance simplification with maintaining environmental integrity (Randall, 2015). The PoA structure also supported the dissemination of such household technologies more efficiently than project-based activities.

Accelerating the CDM reform

At its 63rd meeting in September 2011, the CDM EB decided to establish a High-Level Panel to conduct a policy dialogue involving the civil society, policymakers and market participants. The intent was to review past CDM experience and prepare the mechanism for the post- 2012 period. The Panel was composed of 11 leaders of companies, NGOs and governmental bodies not directly involved in the CDM. The policy dialogue consisted of 58 public input submissions, 18 consultations with stakeholders and 17 informal meetings. In September 2012 at the 69th meeting of the CDM EB, the Panel published the final report consisting of 51 recommendations that address not only the CDM EB, but also other stakeholders including national governments, the UNFCCC and project participants (UNFCCC, 2012).

Key issues addressed in the CDM Policy Dialogue were: (i) streamlining the project cycle; (ii) changing the methods for determining additionality; (iii) modifying the role of the secretariat; (iv) improving the validation and verification model; (v) professionalization of the EB; (vi) implementation of an appeals mechanism; and (vii) strengthening the current stakeholder consultation system (Classen, 2012).

CARBON MARKETS AND REGULATORY FRAMEWORKS POST-PARIS

Main features of the period: post-Paris revival of carbon markets

From the top down to a bottom up climate policy regime

The 21st Conference of Parties (COP21) held in Paris in December 2015 marked an historical turning point regarding fighting climate change: the Paris Agreement (PA) established ambitious global mitigation targets, with the goal of limiting temperature increase well below 2°C, with efforts to contain the temperature increase within 1.5°C (Art. 2). Moreover, a balance of emissions by sources and removal by sinks is to be reached by the second half of the century (Art 4.1). A global stocktaking (Art. 14.1 and 2) will be undertaken every 5 years, starting in 2023.

Unlike the KP that only covered developed countries, the PA adopted in 2015 involves global participation, which comes, however, at the cost of increasing complexity. The PA requires Parties to submit their Nationally Determined Contributions (NDCs) which indicate mitigation (and in some cases adaptation) targets set on a voluntary basis by each Party under the PA and can also identify the instruments and measures to achieve them. This new regime, however, resulted in a significant level of heterogeneity complicating mitigation accounting (Kreibich and Obergassel, 2016). The international climate regime has thus changed its character from a top-down approach based on mandatory emissions commitments to a bottom-up system of voluntary government pledges. Generally, the transition toward a bottom-up regime risks a reduction of transparency and increases in the transaction costs of mitigation (Michaelowa, 2015). The combination of existing, emerging, and potential carbon market-mechanisms can be regarded as an emerging pre-2020 fragmented global carbon market landscape based on differing bottom-up market-based approaches (Redmond and Convery, 2015).

National carbon markets:

Over the last 15 years, national and sub-national carbon markets, mainly emissions trading systems have proliferated. Not only industrialized countries but also emerging economies, such as Korea and China have introduced emissions trading. In the last five years, also offsetting against carbon taxes has started to be applied. While in the past, most national carbon markets had some link to international carbon markets, the EU's closing of its market for international credits triggered similar closures as countries wanted to prevent being swamped by low-priced international credits. World Bank and Ecofys (2018) provide a comprehensive overview about all carbon pricing instruments, while ICAP (2019) provides an overview of emissions trading initiatives.

Market mechanisms under the Paris Agreement

The fate of international carbon markets post-Kyoto remained uncertain for a number of years. The negotiations under the UNFCCC on the New Market Mechanisms (NMM) and the Framework for Various Approaches (FVA), which covers both market-based and non-market-based approaches, have been ongoing since COP13 in Bali in 2007. Limited progress has been achieved by 2012 and a number of important design elements remained outstanding in the negotiations concerning the NMM and its modalities and procedures (Kulovesi, 2012). These negotiations advanced slowly towards COP21 and the inclusion of cooperative mechanisms into the PA was one of the last-minute surprises (Dransfeld et al. 2016).

In order to encourage international collaboration and improve the cost-effectiveness of the achievement of NDCs, the Article 6 of the PA provides an array of market and non-market mechanisms:

- **Article 6.2** defines Cooperative Approaches (CA) which involve the transfer of "internationally transferred mitigation outcomes" (ITMOs) which can be used to fulfil a country's NDC targets. CAs are generally understood to be a mean through which parties can trade ITMOs bilaterally or in groups for instance through GHG crediting mechanisms, linking of emission trading schemes or direct government-to-government transfers. The mechanism is subject to UNFCCC guidance, but not direct international supervision. It can therefore be compared with International Emissions Trading and the JI Track 1 under the Kyoto Protocol.
- **Article 6.4** establishes a new market mechanism for generation of emissions credits – often called "Sustainable Development Mechanism" (SDM) – which is centrally governed by a UNFCCC body and is also meant to contribute to sustainable development in host

countries. From the governance standpoint, the SDM can thus be compared with the CDM and JI Track 2.

- **Article 6.8**, in contrast to the SDM and CAs, "recognizes" the importance of non-market approaches to (a) Promote mitigation and adaptation ambition; (b) Enhance public and private sector participation; and (c) Enable opportunities for coordination across instruments and relevant institutional arrangements. At this point in time it is unclear how such approaches will function at the end. Article 6.8 might for example become a framework for public climate finance flows.

Key market and regulatory challenges in this period

Increasing the mitigation ambition

Some analysts argue that the new generation of international carbon markets should directly contribute to raising mitigation ambition as opposed to being a "zero-sum game" (Cames et al., 2016). For example, while the CDM could theoretically increase ambition and provide "net mitigation" when crediting periods are shorter than the project lifetime, additionality issues put this possibility into question (Erickson et al., 2014). Discounting carbon credits and using baselines below business-as-usual were put forward as potential ways to provide "net mitigation" (Warnecke, 2014).

One of the suggestions to boost ambition, was the creation of a Club of Carbon Markets (CCM) that would establish common standards for market infrastructure, transparency and environmental integrity (Keohane et al., 2017). It was argued that such a club could foster increased participation in climate change mitigation in the same way as the General Agreement on Tariffs and Trade (GATT) helped broaden trade in products and services.

Linking different national and regional ETS was suggested to improve their economic efficiency and potentially help raise ambition. At the same time, there are some important risks related to linking, such as loss of control over domestic carbon policies (Ranson and Stavins 2016). "Exchange rates" were suggested to be used for linked systems in a similar way as currency exchange rates function (Pillay and Vinuales, 2016). Earlier research by Haites and Wang (2009) point out that linking different emission trading schemes does not in itself necessarily ensure higher environmental integrity of the linked systems. Moreover, actual difficulties should be considered and policy development and institutional cooperation are necessary to link different schemes. Tuerk et al. (2009) found that at that time only little advancement could be theoretically made to link different schemes, due to differences in policy priorities and needs for harmonization. Even if difficulties are present due to different domestic and international policies, it was argued that the EU and the USA would benefit from a linked carbon market (Sterk and Kruger, 2009). While the questions of linking national and regional carbon markets have been open for a decade, the issue of linking the fragmented carbon pricing initiatives becomes particularly important in the post-Paris international climate regime given the absence of a universal linking mechanism.

Baselines and additionality for the Paris Mechanisms

While the Article 6 mechanisms may provide governments with access to less costly mitigation options, they could also provide an important incentive to increase the ambition of NDCs over time.

However, in order for this potential to be realized additionality must be defined carefully in the context of the Paris Agreement, especially if applied to policy instruments (Michaelowa, 2017).

Using the CDM experience, it was argued early on that new market mechanisms should be focused on ensuring a high level of environmental integrity (Newell 2012a) particularly through the determination of project additionality (Bento et al., 2015a; Michaelowa and Butzengeiger, 2017) and the emissions baseline used to calculate crediting volumes (Michaelowa, 2012; Bento et al., 2015b). Indeed, many NDCs have baselines that are above any credible business-as-usual path. It is thus highly likely that a significant number of NDCs would generate “hot air” if NDC baselines were to be used as a basis for crediting emission reductions or allocating emission allowances. The experience gained with JI leads to a clear recommendation for the Paris mechanisms – international oversight is crucial to prevent transfers of “hot air” (Michaelowa and Hoch, 2017). The issue of additionality under the Article 6 of the PA is further complicated by three factors (Spalding-Fecher et al., 2017). First, the nature of the conditionality of the NDC pledges is not clear. Secondly, there is a number of technical issues with translating the NDC pledges into metrics that are suitable for baselines and additionality assessment. Thirdly, using NDC pledges for crediting baselines assumes that these pledges are below business-as-usual emissions, which is not the case in practice (Michaelowa and Hoch, 2017). In the context of the Article 6 of the PA an additionality algorithm was suggested depending on whether a given activity is covered by an NDC, whether it is conditional or unconditional and whether an NDC is likely to generate “hot air” (Michaelowa et al. 2019).

An important issue that was raised for renewable energy projects in developing countries was the fact that in in the context of widespread energy shortage, the extra electricity produced by the CDM projects is more likely to be used to provide extra electricity supply rather than substitute the Business-as-usual (BAU) electricity supply (Zhu and Tang, 2015). Appropriate baseline setting was found to be the best instrument for minimizing non-additional offsets compared to trade ratios and quantitative limits (Bento et al., 2015b).

It will also be important to make sure that the flexibility mechanisms do not deter setting ambitious emissions reduction targets and/or policies. Indeed, some researchers argued that the CDM is not neutral on the global level of carbon emissions as it entices countries to raise their emission caps (Brechet et al., 2016). It was therefore suggested that for future market mechanisms, a coordinated approach is needed to address potential trade-offs between global and national incentives at the sector-wide level (Liu, 2015).

Issues related to Monitoring, Reporting and Verification (MRV)

MRV is paramount in ensuring the environmental integrity of carbon markets and will therefore have to be properly addressed in the rules for the implementation of the Article 6 of the Paris Agreement. MRV, however, comes at a cost that in the CDM ranged from several cents to EUR 1.20 and above per tCO_2e depending on the project type. Generally, there is a trade-off between the stringency and the cost of monitoring, which if not addressed properly may become a major barrier for the implementation of mitigation projects in some sectors, particularly in the context of currently low international carbon prices (Shishlov and Bellassen, 2016). For example, monitoring rules under the CDM are often more stringent than those under the EU ETS, which could potentially put an unreasonable burden on project developers (Warnecke, 2014).

Double counting is another important carbon accounting issue that needs to be addressed under the PA. The key challenge is that double counting can occur in several different ways, such as double issuance and double claiming. While avoiding these problems is difficult it is technically possible through a coherent set of rules for accounting of units, design of mechanisms, and tracking and reporting of units (Schneider et al., 2015).

The future role of the CDM

The future role of the CDM remains uncertain and will depend upon the evolution of countries' NDCs and the development of the Article 6 rulebook. While the CDM is part of the KP, it could theoretically continue beyond 2020, for example, if recycled into the Sustainable Development Mechanism under Article 6.4 of the PA. In this respect, different scenarios for the CDM future – from expansion to phase-out – can be envisaged (Vivid Economics, 2012).

With regards to pre-2020 action, several recommendations were made, most notably (Cames, 2016):

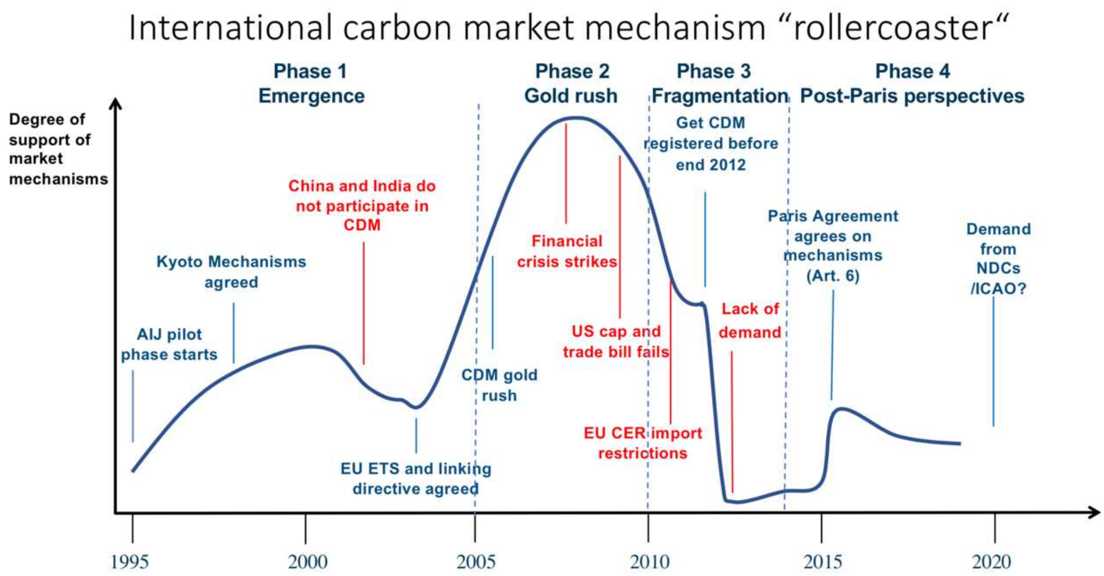
- Limiting the purchase of CERs to either existing projects with discontinuation risk, such as landfill gas flaring, or to new projects that have a high likelihood of ensuring environmental integrity.
- Accompanying purchase of CERs with support for a transition of host countries to broader and more effective climate policies.
- Focusing international crediting mechanisms to address specific emission sources in countries that do not have the capacity to implement alternative climate policies.

In some instances, the CDM might be seen as a transition mechanism to other climate policies, once the abatement cost has been discovered by the market. This was the case, for example, with HFC emissions that were included in direct regulations under the Montreal Protocol after the initial experience under the CDM. In some countries – most notably China – the CDM is being transformed into a domestic offsetting mechanism under the newly piloted national carbon trading scheme with more than 2000 projects re-validated for this purpose (Lo and Cong, 2017).

Conclusion

The international carbon markets experienced widely varying fortunes since the 1990s. This is due to political and economic drivers that affect the development of the carbon markets. The following figure depicts the different phases and fortunes of market mechanisms, as well as their key drivers.

Figure 4. Differing fortunes of international carbon markets over time



Source: authors

The emergence period is characterized by the introduction of market mechanisms as a climate change mitigation tool. Parties to the UNFCCC negotiated the definition of the flexible mechanisms that were included in the Kyoto Protocol (1997) and their operational rules and procedures that were included in the Marrakech Accords (2001). The operationalization of the CDM and JI required the establishment of officially approved baseline and monitoring methodologies and piloting activities in different sectors. The nascent carbon market was characterized by the lack of demand from the private sector making the initial participation of the public sector through various credit purchasing programs and carbon funds crucial.

After the initial testing period, the carbon markets entered a phase of great expansion. This period is characterized by significant changes in markets and regulatory frameworks as the EU ETS became operational and was linked to the CDM creating a large source of demand for carbon credits from the private sector adding to the demand from governments, e.g. in Japan. Large developing countries, such as China, India, Brazil, Mexico and South Korea became the largest suppliers of carbon credits under the CDM. This raised concerns about the uneven distribution and limited participation of LDCs. The introduction of the PoA concept was aimed at addressing this issue. In terms of the sectoral breakdown, the supply of carbon credits was initially dominated by industrial gas projects that provided a cheap GHG abatement opportunity but raised criticism for creating perverse production incentives and not contributing to sustainable development. Additionality also emerged as a key issue particularly for large-scale renewable energy projects, such as large hydro. In the second part of the gold rush period, regulation regarding assessment of CDM project additionality and verification was strengthened significantly, with validators and verifiers becoming more careful following suspensions of accreditations by the regulators due to low quality work.

The fragmentation period is characterized by a sudden decline in carbon prices between 2011 and 2013 and the resulting decline in the development of new carbon projects. This is related to both domestic and international regulatory regimes. At the domestic level, the issuance of carbon credits started reaching the quantitative limits on the use of offsets in the EU ETS effectively eliminating the largest source of demand. The qualitative limits on the use of offsets that were introduced by the EU starting in 2013 therefore did not really matter. At the international level, the uncertainty surrounding the second Kyoto Commitment Period resulted in decreased demand from governments. The carbon market price collapse also led to multiple bankruptcies or scaling down of specialized consulting firms, in turn resulting in the gradual loss of expertise as specialists moved to other fields.

Table 1 below summarizes the features and challenges of the four periods.

Table 1: Key features and challenges of the different carbon market periods

Time period	Main features of the period	Key challenges
1997 – 2005 Emergence	- Parties negotiate for the definition of the flexible mechanisms and for the definition of their operational rules and procedures - After initial testing through AIJ, the CDM, JI and IET are agreed - Initial implementation of activities in different sectors - Carbon markets created and catalysed to demonstrate the potential for low cost emission reduction and compliance with Kyoto targets - Environmental integrity and economic efficiency of the mechanisms are studied in detail	- Evaluation of the cost effectiveness and associated risks for investors - Initial testing of different design models - Environmental integrity and contribution to Sustainable Development - Baseline setting and additionality concerns - Provision of incentives for technology transfer and innovation - Definition of eligible activities and associated issues for the forestry sector - Forestry projects are criticized for the negative impacts on SD at local level and for indigenous people
2006-2011 “Gold rush”	- After the initial testing period the carbon markets start a phase of great expansion. - EU is the main source of demand for CDM credits while China and India dominate their supply - Improvements of the rules of the CDM, with operationalization of the PoA concept reducing transaction costs of small-scale projects and contribute to a more balanced distribution - Governance and institutional set up, including capacity building needs, emerge as a key element for the carbon market functioning	- Additionality and baseline setting face significant issues affecting the environmental integrity of the CDM - Questionable contribution to SD and technology transfer - “Low hanging fruits” and uneven geographical distribution, penalizing Africa - Forest sector under close scrutiny also during this period, to avoid adverse impacts and ensure delivery of local SD benefits - Projects risks are assessed in more detail, through analysis of several years of operations
2012-2014 Fragmentation	- After the “gold rush”, uncertainties on the future climate regime and lack of mitigation ambition of Annex I countries affect the carbon markets negatively - After failure of the Doha Amendment in December 2012 on ratification of the second commitment period of Kyoto (CP2), prices drop quickly reaching all-time low. Investors have less confidence on market mechanisms - Regarding the JI and CDM, only PoAs still show signs of life, with submission for	- Carbon credit supply hits the EU’s demand ceiling - Supply-demand disequilibrium leads to carbon price collapse - Carbon prices are too low to spur the development of new projects - Risk of project discontinuation and capacity loss

Time period	Main features of the period	Key challenges
	registrations and issuances, although with limited numbers - CDM reforms in order to reduce transaction costs	
2015 – 2018 Post-Paris perspectives	- Prices in the carbon markets are still very low. Limited activities in the international carbon markets - The PA brings positive developments regarding market instruments through Article 6. Detailed modalities and procedures for the new mechanisms (i.e. the SDM and CAs) are still to be defined - An increasing number of developed and developing countries implements or plans to do so, carbon pricing initiatives, some of which allow use of credits	- Need to increase mitigation ambition at global level, particularly given that many NDCs may generate "hot air" - Transition of the CDM to the PA is contentious. Issues with baselines and additionality, and on MRV - Stronger emphasis on the importance of SD benefits and need to avoid negative impacts of market mechanisms

The post-Paris period is characterized by significant changes in the international climate regime that will affect the development of carbon markets in the future. Unlike the Kyoto Protocol that only covered developed countries, the Paris Agreement adopted in 2015 involves global participation, which comes, however, at the cost of increasing complexity. Instead of a uniform formula of "carbon budgets" translated in tonnes of CO_2eq, the Paris Agreement requires Parties to define their Nationally Determined Contributions (NDCs) indicating the voluntarily set mitigation targets for each Party, while the adaptation targets may not be included. While the Paris Agreements includes provisions for market mechanisms through Articles 6.2 and 6.4, their modalities and procedures have not been adopted yet and the practical implementation remains uncertain. Principally, their scope could be upscaled to cover policy instruments or even entire sectors, which will inevitably raise issues how to guarantee additionality and set crediting baselines. While the international carbon market remains uncertain, an increasing number of domestic carbon pricing initiatives have been launched around the world in the past several years.

Past experiences with carbon markets show key necessary conditions for a successful operation of these mechanisms. First, markets are dependent on mitigation ambition and the willingness of governments to create direct or indirect demand for emission credits. Second, the direct involvement of the private sector is crucial to rapidly mobilize mitigation activities of various types and scales. Third, the environmental integrity is crucial to ensure credibility and acceptability in a time where markets generally are put into doubt. Fourth, complexity and related transaction costs have to be managed carefully in order not to stifle activities. All of these conditions are not yet fulfilled under the Paris Agreement. In order to upscale activities under market mechanisms and to ensure that government engagement focuses on the right issues, we suggest that the interactions of market mechanisms with domestic mitigation policies are considered carefully, that baseline setting and additionality determination take into account the significant risk of hot air creation by insufficiently ambitious NDCs and that the public and NGOs are reconciled with market mechanisms through robust safeguards against negative social and environmental impacts.

The current process of revision of Nationally Determined Contributions and the setting of rules for Article 6 provide two crucial opportunities to ensure that international market mechanisms can play their role in achieving the ambitious long term targets of the Paris Agreement.

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Further Reading

cdm.unfccc.int: Website of CDM regulators with full information on projects and regulatory resources cdmpipeline.org: Regularly updated database of all CDM and JI projects

https://openknowledge.worldbank.org/handle/10986/29687: Report on current status of national and international carbon pricing and market mechanisms